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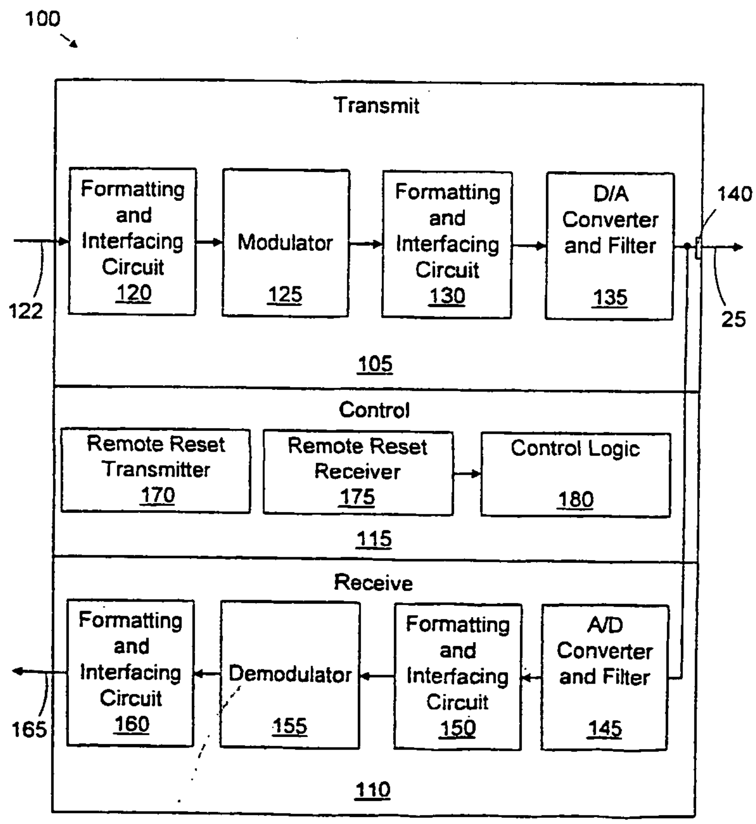
(54) Title: METHOD AND APPARATUS FOR REMOTELY RESETTING A MODEM

(57) Abstract

A modem (100) includes an external line interface (140), a modulator (125), a demodulator (155), and a remote reset transmitter (170). The modulator (125) is adapted to generate outgoing data for transmission over the external line interface (140). The demodulator (155) is adapted to receive incoming data from the external line interface. The remote reset transmitter (170) is adapted to generate at least one of a remote reset signal and a remote reset message for transmission over the external line interface (140). A method for resetting a modem is provided. The method includes generating reset information in a first modem. The reset information includes at least one of a reset signal and a reset message. The reset information is transmitted to a second modem. The second modem is reset in response to the reset information.



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METHOD AND APPARATUS FOR REMOTELY RESETTING A MODEM

TECHNICAL FIELD

This invention relates generally to communication between modems, and, more particularly, to a method and apparatus for remotely resetting a modem.

BACKGROUND ART

Modems are being developed having ever-increasing numbers of features and degrees of configurability. As a result, the circuitry and program instructions required to operate these modems are becoming increasingly complex. In some systems, remote modems are used to connect to centralized modems in managed communication network systems. Due to the complexity of the modems, it is possible that one of the modems may become misconfigured. The communication network service may have certain performance expectations, such as guaranteed uptime, quality of service, *etc.* that could be compromised by a misconfigured modem on either end of the connection.

In some managed communications systems, such as an asymmetric digital subscriber line (ADSL) system, the remote modem may not be owned by the same entity that operates the system. For example, a phone carrier may manage the network and a customer may purchase and operate the remote modem. If either of the central office modem or remote modem is misconfigured, it would be difficult for the entity on the other end of the line to contact the operator of the misconfigured modem to reset the modem to allow for proper communication. This situation is problematic for both the customer and the managing entity.

The present invention is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

DISCLOSURE OF INVENTION

One aspect of the present invention is seen in a modem including an external line interface, a modulator, a demodulator, and a remote reset transmitter. The modulator is adapted to generate outgoing data for transmission over the external line interface. The demodulator is adapted to receive incoming data from the external line interface. The remote reset transmitter is adapted to generate at least one of a remote reset signal and a remote reset message for transmission over the external line interface.

Another aspect of the present invention is seen in a method for resetting a modem. The method includes generating reset information in a first modem. The reset information includes at least one of a reset signal and a reset message. The reset information is transmitted to a second modem. The second modem is reset in response to the reset information.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

Figure 1 is a block diagram of a communications system in accordance with the present invention;

Figure 2 is a simplified block diagram of a modem in accordance with the present invention;

Figure 3 is a diagram of the format of a remote reset message sent by the modem of Figure 2; and

Figure 4 is a diagram of an alternative format for the reset message sent by the modem of Figure 2.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to

the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

MODE(S) FOR CARRYING OUT THE INVENTION

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

Referring to Figure 1, a block diagram of a communications system 10 is provided. The communications system 10 includes a first modem 15 coupled to a second modem 20 through a connection 25. In the illustrated embodiment, the second modem is part of a central office 30, and the connection 25 is an ordinary twisted pair connection, as is common in present-day telephone networks. However, other connection types are contemplated, depending on the specific implementation. Also, it is contemplated that the second modem 20 may not be part of the central office 30.

In the illustrated embodiment, the second modem 20 acts as a gateway to a larger communications network (not shown), such as a local or wide area network, or the Internet. Typically, the first modem 15 establishes a connection to the communications network (not shown) through the second modem 20. Under certain circumstances, as described above, either the first modem 15 or the second modem 20 may become misconfigured. The modem 15, 20 that is functioning properly may send a remote reset signal to the misconfigured modem 15, 20 causing the misconfigured modem 15, 20 to perform a self-check, and enter a known state ready for normal initialization and communication. It is contemplated that only one of the first and second modems 15, 20 may be adapted to receive a remote reset signal. For example, the first modem 15 may be adapted to remotely reset the second modem 20, or vice versa. Alternatively, the first or second modem 15, 20 may be adapted to both send a remote reset signal and receive a remote reset signal.

Referring to Figure 2, a simplified block diagram of a modem 100 is provided. The modem 100 may be the first modem 15 or the second modem 20. For clarity and ease of illustration, not all functional blocks are illustrated in detail, because these items are known to those of ordinary skill in the art, and are further defined in well known modem standards.

The modem 100 includes transmit, receive, and control functional blocks 105, 110, 115. The transmit block 105 includes a formatting and interfacing circuit 120 adapted to receive outgoing digital data over a data-out line 122. The formatting and interfacing circuit 120 performs functions such as cyclic redundancy checking (CRC), scrambling, forward error correction, and interleaving. As stated above, these functions are known to those of ordinary skill in the art. The transmit block 105 also includes a modulator 125 that receives data from the formatting and interfacing circuit 120 and modulates a carrier or carriers with the data. The modulator 125 performs an inverse discrete Fourier transform (IDFT) function to provide time domain waveform samples. A second formatting and interfacing circuit 130 buffers the samples received from the modulator 125. A digital to analog (D/A) converter and filter 135 converts the samples from the formatting and interfacing circuit 130 to an analog waveform suitable for transmission over the connection 25 through an external line interface 140.

Other functions may be performed by the modulator 125 and formatting and interfacing circuits 120, 130, depending on the specific protocol of the modem 100. For example, if the modem 100 were to use an asymmetric digital subscriber line (ADSL) protocol (ANSI T1.413 Issue 2, entitled, "Interface Between Networks and Customer Installation - Asymmetric Digital Subscriber Line (ADSL) Metallic Interface, Rev. R4, dated 6/12/98, the modulator 125 would perform tone ordering, constellation encoding, and gain scaling functions in accordance with the number of available tones. Also, the second data formatting and interfacing circuit 130 would insert a cyclic prefix to the output of the modulator 125 (*i.e.*, a subset of the output samples from the modulator 125 is replicated and prepended to the existing output samples to provide an overlap and allow for better frame alignment when the output from the modem 100 signal is ultimately received by an interfacing modem (not shown).

The receive block 110 includes an analog to digital (A/D) converter and filter 145 that receives an analog waveform over the connection 25 and samples the analog waveform to generate a time domain digital signal. A formatting and interfacing circuit 150 performs functions known in the art such as frame alignment and time domain equalization. In time domain equalization, because the tones are at different frequencies, certain frequencies travel faster than others, and as such, all the tones do not arrive at same time. The time domain equalization function of the formatting and interfacing circuit 150 delays the faster tones to compensate for the propagation speed differences. There is a performance trade off between the frame alignment and time domain equalization functions in that a higher degree of frame alignment accuracy allows a lesser degree of accuracy in time domain equalization. The cyclic prefix insertion performed by the interfacing modem (not shown) improves frame alignment accuracy. The formatting and interfacing circuit 150 also performs gain control to increase the amplitude of the received signal.

A demodulator 155 receives the time domain samples from the formatting and interfacing circuit 150 and converts the time domain data to frequency domain data. The demodulator 155 performs a slicing function to determine constellation points from the constellation encoded data, a demapping function to map the identified constellation point back to bits, and a decoding function (*e.g.*, Viterbi decoding if trellis constellation coding is employed). In the case where the modem operates using the ADSL protocol, the demodulator 155 also performs tone deordering to reassemble the serial bytes that were divided among the available tones. A second formatting and interfacing circuit 160 in the receive block 110 performs forward error correction, CRC checking, and descrambling functions on the data received from the demodulator 155. The reconstructed data provided by the formatting and interfacing circuit 160 represents the sequential binary data that was sent by the interfacing modem (not shown). The reconstructed data is provided to a data-in line 165.

The control block 115 includes a remote reset transmitter 170 adapted to send a remote reset signal to an interfacing modem (not shown) over the connection 25, a remote reset receiver 175 adapted to receive a remote reset signal or remote reset message from the interfacing modem (not shown), and control logic 180 adapted to reset the modem 100 in response to the remote reset signal or message. The operation of the remote reset transmitter 170 and the remote reset receiver 175 is described below as it may be implemented in view of various modem protocols.

As stated above, the modem may be configured to operate under any number of modem protocols, including voice band protocols (*e.g.*, V42, V8bis, V90) and/or high bandwidth protocols (*e.g.*, T1.413-ADSL). For illustrative purposes, the modem 100 of the present invention is described as it may be implemented under the V8bis voice band protocol (ITU-T standard Draft V8.bis, entitled "Data Communication Over the Telephone Network – Procedures for the Identification and Selection of Common Modes of Operation Between Data Circuit

Terminating Equipment (DCE) and between Data Terminal Equipment (DTE) Over the General Switched Telephone Network and On Leased Point-to-Point Telephone-Type Circuit," dated 12/11/85, or under the ADSL protocol (cited above). One of ordinary skill in the art will appreciate that the concepts described herein may be adapted for use with any present or future modem protocol.

Modems are generally capable of communicating control information using either signals or messages. Signals are generally defined as information sent by varying the characteristics of the transmitted analog waveform, and messages are generally defined as information sent as digital data modulated by the carrier waveform. To decode a message the carrier waveform is demodulated and the digital message is extracted. The remote reset transmitter 170 may be configured to send a remote reset signal using a signal, a message, or both, depending on the specific application. Likewise, the remote reset receiver 175 may be adapted to receive a message, a signal, or both. For example, the remote reset transmitter 170 may send a remote reset signal followed by a remote reset message to the interfacing modem (not shown). The interfacing modem (not shown) receives the reset signal and prepares for the reset message. If the reset message is not verified, the interfacing modem (not shown) may choose not to perform the reset. Conversely, the interfacing modem (not shown) may choose to perform a reset based only on the reset signal. If the interfacing modem (not shown) is misconfigured (*i.e.*, a situation in which a reset may be desirable), it may not be able to decode the reset message. If both the reset signal and the reset message were required to be received, a misconfigured modem may not be able to be reset.

The choice of which reset information to use (*i.e.*, signal, message, or both) is application specific. If it is desired to reset only with a high degree of certainty, verification of both may be required. If it is desired that a misconfigured modem be easily reset, only a remote reset signal may be required. In the case where only a remote reset signal is required, the remote reset receiver 175 may be coupled to the connection 25 independently of the normal modem 100 circuitry, such that it may receive a remote reset signal, even if the modem 100 is not functioning.

In response to a remote reset, the modem 100 may enter an idle state, may reinitialize and perform a self-test, or may initiate an initialization sequence similar to its power-up sequence. The particular reset state is application specific, and thus, may vary. It is also contemplated that the reset state of the modem 100 may be configurable.

For exemplary purposes, the constructs of a remote reset signal and a remote reset message are described as they may be implemented under a voice band protocol, such as V8bis. V8bis signals that initiate a transaction (*i.e.*, initiating signals) and signals that are sent in response to initiating signals (*i.e.*, responding signals) are tone based. Each signal includes two segments. The first segment is a dual tone multifrequency (DTMF) signal that indicates whether the signal is an initiating signal or a responding signal. Initiating signals are designated by the tone pair of 1375 Hz and 2002 Hz and responding signals are designated by the tone pair of 1529 Hz and 2225 Hz. Detectors (not shown) for identifying the presence of DTMF or single tone signals are well-known to those of ordinary skill in the art.

The second segment includes a single tone that designates a specific command. For example, a segment 2 frequency of 1650 Hz indicates an escape signal. The nominal durations of the first and second segments are 400 ms and 100 ms, respectively. To generate a remote reset signal, the remote reset transmitter 170 would send a first segment including the initiating signal tone pair, followed by a second segment including a single tone designated as a reset tone. The particular frequency chosen for the second segment reset tone is application specific and depends on the frequencies already chosen for other signals.

It is contemplated that remote reset transmitter 170 may be adapted to generate a remote reset signal acknowledgement in response to receiving a remote reset signal from the interfacing modem (not shown). The remote reset transmitter 170 would send a first segment including the initiating signal tone pair, followed by a second segment including a single tone designated as a reset tone.

Although the reset signal is illustrated as a dual tone segment followed by a single tone segment, the invention is not so limited. It is contemplated that the reset signal may be generated using various constructs. The construct of the reset signal should be chosen such that the signal would not be a naturally occurring combination that might be encountered during data transmission or normal operation of the modem 100. For example, the reset signal may be constructed using a series of phase reversals, a series of amplitude modulations (*i.e.*, a predetermined pattern of high level and low level signals), or the like that are not naturally occurring.

Within the context of the ADSL protocol, it is contemplated that other reset signals may be constructed. For example, the medley or segue signals may be used to interrupt normal data signals. The inversion of the synchronization symbol, or the inversion or other change of the pilot tone in known patterns may be used. Also, a period of silence followed by any of the other signals may be used.

The use of a V8bis message to generate a remote reset message is described below. Figure 3 illustrates the format convention used for a message 200. The message 200 is partitioned into octets 205 (*i.e.*, groups of 8 bits). Each message 200 begins with at least two (no more than five) flag octets 210 (*i.e.*, 01111110). Each message also ends with at least one (no more than three) flag octet 210. The message 200 includes at least one information field octet 215, followed by first and second frame check sequence field (FCS) octets 220, 225. The FCS field octets 220, 225 are computed based on the bits contained in the information field octets 215 and provide a verification that the proper message 200 was received.

To generate the reset message, the information field octet 215 is encoded with a unique bit pattern associated with the reset command. It is contemplated that the message may include information pertaining to the type of reset requested (*e.g.*, return to idle state, or full reset). Using a remote reset message 200, as described above, ensures the validity of the reset. Because the message must be decoded and verified (*i.e.*, by the FCS), it is unlikely that an inadvertent message could be received.

The generation of a remote reset signal and a remote reset message is now illustrated with respect to the modem 100 operating under the ADSL protocol. As defined in the ADSL standard, signals are generated using discrete sinusoids selected from one of the 256 typically available tones. For example, an activate signal (*e.g.*, C-ACT1) is generated using a 207 Hz sinusoid on channel 48. All of the other channels are at a level of zero. The amplitude of the signal is held at a first level for a first period of time and a second level for a second period of time. In a similar manner, a remote reset signal is defined using a discrete sinusoid frequency and a predetermined amplitude pattern.

Also defined in the ADSL standard is an embedded operations channel (EOC) reserved for transferring messages between the central office modem 20 and the modem 15 at the customer installation. The partitioning of an EOC message 300 is illustrated in Figure 4. The 13-bit EOC message includes an address field 305 (bits 1-2), a data/opcode field 310 (bit 3), a byte parity field 315 (bit 4), a message/response field 320 (bit 5), and an information field 325 (bits 6-13).

The address field 305 specifies the destination of the message (*i.e.*, 11 – central office modem 20, 00 – customer modem 15). If the reset message is being sent by the customer modem 15, the address field 305 would be set to 11. The data/opcode field 310 indicates whether the information field 325 contains a data byte (0) or an

opcode (1). The byte parity field 315 specifies even (0) or add (1) parity. The message/response field 320 specifies whether the message is an autonomous message (0) or a non-autonomous message. Because the reset message causes the receiving modem 15 or 20 to change states, it is not autonomous (*i.e.*, message/response field 320 set to 1). The information field 325 contains an opcode corresponding to the reset message. The specific opcode chosen for the reset message is application specific, and depends, in part, on the opcodes previously assigned to other messages. Assuming the opcode designated for the reset message is 15, an exemplary EOC reset message may have a bit pattern of "0000111111111," where the two least significant bits are the address field 305, and the eight most significant bits are the opcode. In the exemplary bit pattern the customer modem 15 is sending the reset message to the central office modem 20. It is contemplated that the central office modem 20 may send a response message indicating receipt of the reset message.

It is contemplated that other reset message constructs may be used in the context of the ADSL protocol. For example, other types of channels that can carry messages simultaneously with the data stream, such as a clear embedded operations channel, may be used.

The particular signal and message constructs described above for generating remote reset signals and messages are provided for illustrative purposes. It is contemplated that many signal and message constructs are possible depending on the specific application and protocol being used. It is also contemplated that the modem 100 may send only a remote reset signal (high probability of detection), only a remote reset message (high degree of certainty due to decoding and check sum), or both a remote reset signal and a remote reset message (highest degree of certainty). As stated above, a misconfigured modem may not be able to properly decode a remote reset message, but may be able to detect a remote reset signal. The particular combination selected depends on the specific application and the degree of certainty desired.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

CLAIMS

1. A modem (100), comprising an external line interface (140), a modulator (125) adapted to generate outgoing data for transmission over the external line interface, and a demodulator (155) adapted to receive incoming data from the external line interface (140)

CHARACTERIZED IN THAT

the modem (100) further comprises:

a remote reset transmitter (170) adapted to generate at least one of a remote reset signal and a remote reset message for transmission over the external line interface (140).

2. A modem (100), comprising an external line interface, a modulator adapted to generate outgoing data for transmission over the external line interface, and a demodulator adapted to receive incoming data from the external line interface

CHARACTERIZED IN THAT

the modem further comprises:

a remote reset receiver adapted to receive at least one of a remote reset signal and a remote reset message through the external line interface; and

control logic adapted to reset the modem in response to one of the remote reset signal and the remote reset message.

3. The modem (100) of claim 1 or 2, wherein the remote reset signal comprises at least one of a dual tone signal having a first duration, a single frequency signal having a second duration, a signal having a phase reversal, and a signal having a predetermined amplitude pattern.

4. The modem (100) of claim 1 or 2, wherein the remote reset message includes a plurality of message bits.

5. The modem (100) of claim 1 or 2, wherein the remote reset message includes a remote reset opcode.

6. The modem (100) of claim 2, wherein the remote reset message includes a plurality of message bits and the remote reset receiver is adapted to decode the message bits.

7. The modem (100) of claim 2, wherein the remote reset message includes a plurality of message bits, the remote reset message includes a checksum, and the remote reset receiver (175) is adapted to verify the message bits based on the checksum.

8. A method for resetting a modem (20), comprising:

generating reset information in a first modem (15), the reset information including at least one of a reset signal and a reset message;

transmitting the reset information to a second modem (20); and

resetting the second modem (20) in response to the reset information.

9. The method of claim 8. wherein generating the reset information includes generating at least one of a dual tone signal having a first duration. a single frequency signal having a second duration. a signal having a phase reversal. and a signal having a predetermined amplitude pattern.

10. The method of claim 8. wherein generating the reset information includes generating a plurality of message bits.

11. The method of claim 8. wherein generating the reset information includes generating a remote reset opcode.

12. The method of claim 8, wherein receiving the reset information includes decoding the message bits.

13. The method of claim 8, wherein generating the reset information includes generating a checksum, and receiving the reset information includes verifying the message bits based on the checksum.

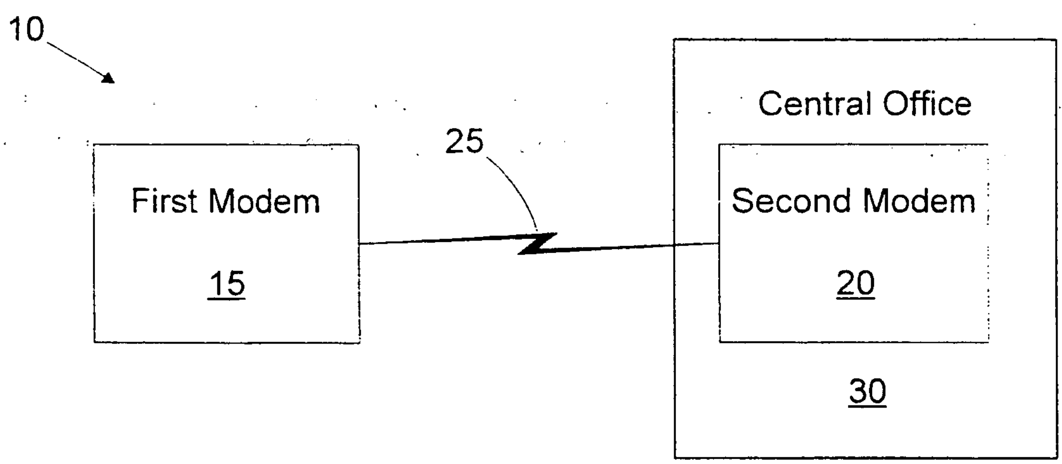

Figure 1

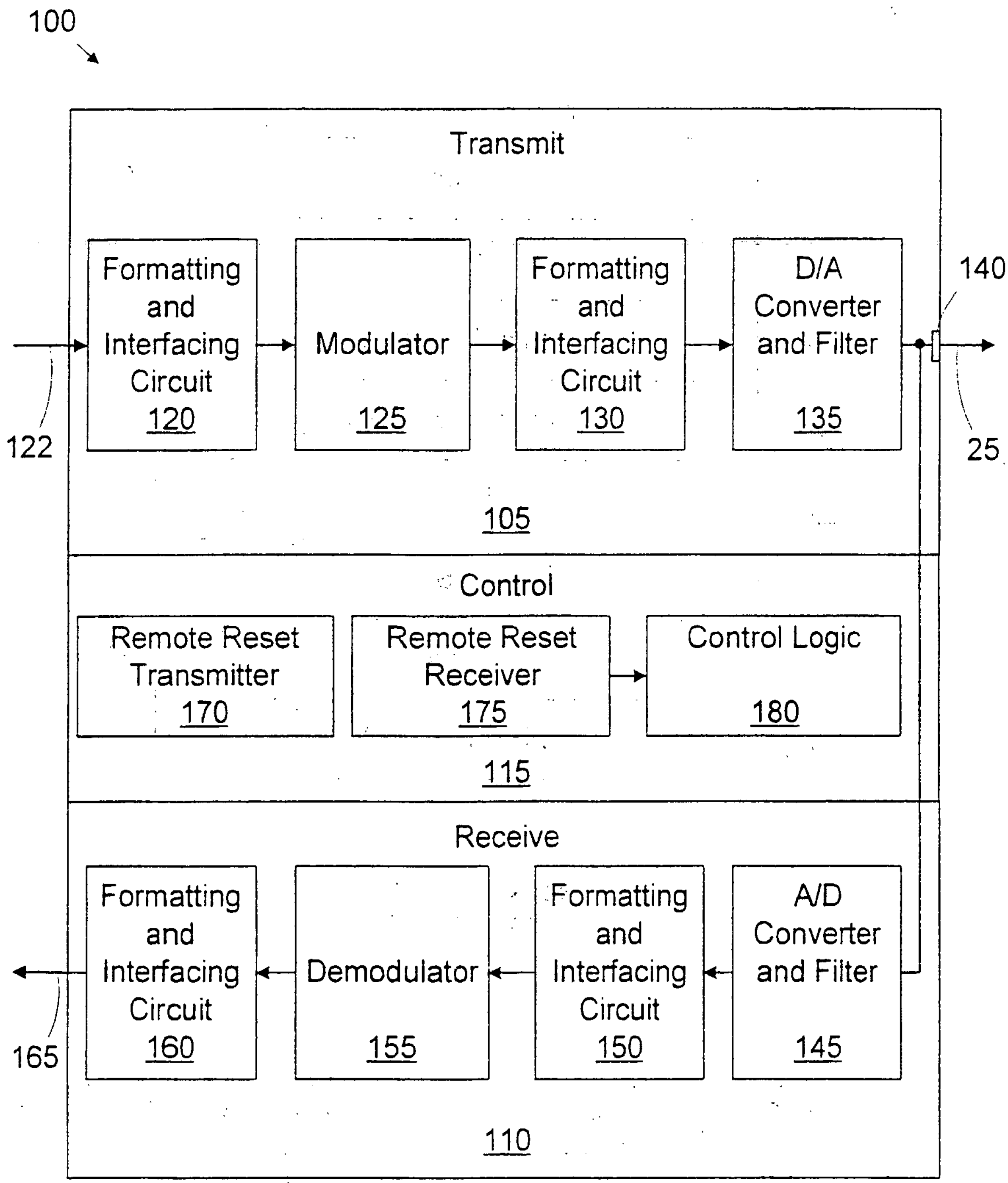
100
Transmit
Formatting and Interfacing Circuit 120
Modulator 125
Formatting and Interfacing Circuit 130
D/A Converter and Filter 135
140
122
25
105
Control
Remote Reset Transmitter 170
Remote Reset Receiver 175
Control Logic 180
115
Receive
Formatting and Interfacing Circuit 160
Demodulator 155
Formatting and Interfacing Circuit 150
A/D Converter and Filter 145
165
110

Figure 2

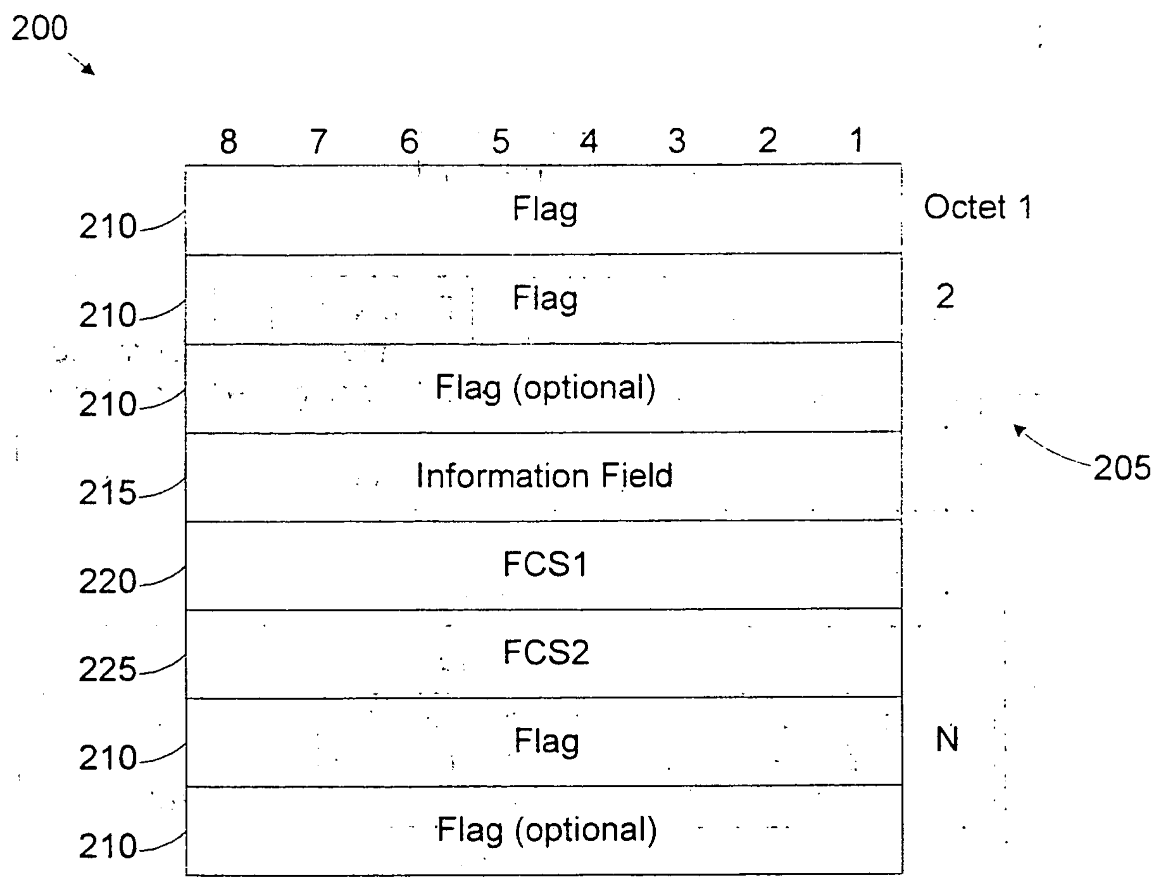

Figure 3

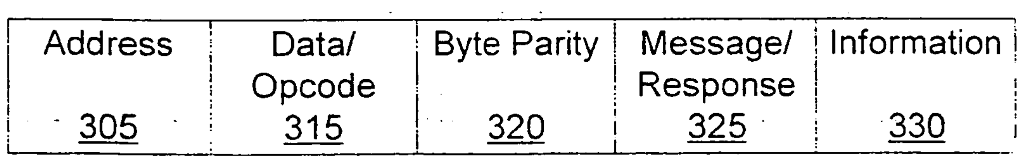

Figure 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/25316

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M11/06 H04L12/12 H04M11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04M H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 5 051 720 A (KITTIRUTSUNETORN KITTI) 24 September 1991 (1991-09-24) column 1, line 12 -column 4, line 26 column 6, line 22-35 ---	1 8
X	FR 2 764 153 A (APITEL ROBOTEL) 4 December 1998 (1998-12-04) page 5, line 6-39 -----	2

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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 May 2000	15/05/2000

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Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5051720	A	24-09-1991	NONE	
FR 2764153	A	04-12-1998	NONE	